

Pond (No.) 378

DEFINITION

A water impoundment made by constructing a dam or an embankment, or by excavating a pit or dugout.

In this standard, ponds constructed by the first method are referred to as embankment ponds and those constructed by the second method are referred to as excavated ponds. Ponds constructed by both the excavation and the embankment methods are classified as embankment ponds if the depth of water impounded against the embankment at the auxiliary spillway elevation is 3 feet (1m) or more.

PURPOSES

To provide water for livestock, fish and wildlife, recreation, fire control, crop and orchard spraying, and other related uses, and to maintain or improve water quality.

CONDITIONS WHERE PRACTICE APPLIES

This standard establishes the minimum acceptable quality for the design and construction of low hazard ponds if:

1. Failure of the dam will not result in loss of life; damage to homes, commercial or industrial buildings, main highways, or railroads; or interruption of the use or service of public utilities.
2. The effective height of the dam is 35 feet (10.7m) or less. The effective height of the dam is the difference in elevation, in feet, between the auxiliary spillway crest and the lowest point in the cross-section taken along the centerline of the dam. If there is no auxiliary spillway, the design top of the dam is the upper limit.
3. The product of the storage times the effective height of the dam is less than 3,000 (1,130,000). Storage is the volume, in acre-feet (m³), in the reservoir below the elevation of the crest of the auxiliary spillway.

Ponds shall be planned, designed, and constructed to comply with all federal, state, and local laws and regulations.

Site Conditions

Site conditions shall be such that runoff from the design storm can be safely passed through: (1) a natural or constructed auxiliary spillway; (2) a combination of a principal spillway and an auxiliary spillway; or (3) a principal spillway.

Drainage Area

The drainage area above the pond must be protected against erosion to the extent that expected sedimentation will not shorten the planned effective life of the structure. The drainage area shall be large enough so that surface runoff and groundwater flow will maintain an adequate supply of water for the intended purpose, unless an alternate water source exists. The water quality shall be suitable for the water's intended use.

Reservoir Area

The topography and soils of the site shall permit storage of water at a depth and volume that ensures a dependable supply, considering beneficial use, sedimentation, season of use, and evaporation and seepage losses. If surface runoff is the primary source of water for a pond, the soils shall be impervious enough to prevent excessive seepage losses or shall be of a type that sealing is practicable. Water shall not be impounded on land that is not owned by the landowner without written permission from the affected landowner.

CRITERIA

General Criteria Applicable To All Purposes

Disturbed areas around ponds and pond embankments and auxiliary spillways shall be vegetated according to the Michigan NRCS Standard Critical Area Planting (342). Use vegetation adapted to the site that will accomplish the desired purpose. Preference shall be given to native species in order to reduce the introduction of invasive plant species; provide management of existing invasive species; and minimize the economic, ecological, and human health impacts that invasive species may cause. If native plant materials are not adaptable or proven effective for the planned use, then non-native species may be used. Refer to the Field Office Technical Guide,

Section II, Invasive Plant Species, for plant materials identified as invasive species.

Design Criteria For Embankment Ponds

Geologic Investigation

A subsurface investigation is required for all embankment ponds. Subsurface investigations shall be conducted by individuals trained in soil science, engineering, geology, or a related field. The number and depth of test holes, pits, or borings will vary depending on the planned embankment height and length and the conditions encountered during the investigation such as the complexity of the soils, the depth to groundwater, and the presence or absence of seeps. At a minimum, there shall be one test hole, pit, or boring for each 200 feet (60m) of planned embankment, plus at least one test hole, pit, or boring for the auxiliary spillway, if applicable. The log for each test hole, pit, or boring shall indicate the following:

- Existing ground surface elevation.
- A description of the soil material encountered using the Unified Classification System.
- Depth to changes in the soil material encountered.
- Depth to any seeps encountered.
- Depth to high water (note method of determination: mottling, free water encountered, etc.).
- Depth to bottom of test hole, pit, or boring.

The location and log information for all test holes, pits, and/or borings in or near the structure shall be shown on the construction drawings.

Foundation Cutoff

A cutoff of relatively impervious material shall be provided under the dam, if necessary, to reduce seepage through the foundation. The cutoff shall be located at or upstream from the centerline of the dam. It shall extend up the abutments as required and be deep enough to extend into a relatively impervious layer or provide for a stable dam when combined with seepage control. The cutoff trench shall have a bottom width adequate to accommodate the equipment used for excavation, backfill, and compaction operations. Side slopes shall not be steeper than one horizontal to one vertical. Unsuitable foundation material such as organic matter, grasses, weeds, sod, debris, soft soils, and stones larger than 12 inches (30cm) in diameter shall

be removed from the foundation before earth fill is placed.

Seepage Control

Seepage control is to be included if: (1) pervious layers are not intercepted by the cutoff; (2) seepage could create swamping downstream; (3) such control is needed to ensure a stable embankment; or (4) special problems require drainage for a stable dam. Seepage may be controlled by: (1) foundation, abutment, or embankment drains; (2) reservoir blanketing; or (3) a combination of these measures.

Earth Embankment

The minimum top width for a dam is shown in Table 1. If the embankment top is to be used as a public road, the minimum width shall be 16 feet (5m) for one-way traffic and 26 feet (8m) for two-way traffic. Guardrails or other safety measures shall be used where necessary and shall meet the requirements of the responsible road authority. If the embankment is to be used for maintenance or farm roads, a minimum top width of 12 feet (3.7m) shall be used. Embankment side slopes and top widths for wetland restorations shall be as required by this standard or Michigan NRCS Standard Wetland Restoration (657), whichever requires flatter slopes and wider top widths.

TABLE 1 - Minimum Top Width for Embankments

Total Height of Embankment <i>Feet (m)</i>	Top Width <i>Feet (m)</i>
Less than 10(3)	6(1.8)
10-14.9(3-4.5)	8(2.4)
15-19.9(4.5-6)	10(3)
20-24.9(6-7.5)	12(3.6)
25-35(7.5-10.7)	14(4.2)

The combined upstream and downstream side slopes of the settled embankments shall not be less than five horizontal to one vertical, and neither slope shall be steeper than two horizontal to one vertical. All slopes must be designed to be stable, even if flatter side slopes are required. Berms may be used to achieve stable slopes.

If needed to protect the slopes of the dam from erosion, special measures such as berms, rock riprap, sand-gravel, soil cement, or special vegetation shall be provided.

The minimum elevation of the top of the settled embankment shall be 1 foot (30cm) above the water

surface in the reservoir, with the auxiliary spillway flowing at design depth. The minimum difference in elevation between the crest of the auxiliary spillway and the settled top of the dam shall be 2 feet (0.6m) for all dams having more than a 20 acre (50ha) drainage area or more than 20 feet (6m) in effective height.

The design height of the dam shall be increased by the amount needed to ensure that after settlement the height of the dam equals or exceeds the design height. This increase shall not be less than 5 percent for mineral foundation soil and 33 percent for organic foundation soil to allow for settlement, except where detailed soil testing and laboratory analysis shows a lesser amount is adequate.

Compaction of the earthfill materials shall be completed in accordance with Michigan Construction Specification MI-154, Earthfill.

Principal Spillway

A pipe conduit, with needed appurtenances, shall be placed under or through the dam, except where rock, concrete, or other types of mechanical spillways are used or, where the height is 20 feet (6m) or less, the drainage area is 20 acres (50ha) or less, and the rate and duration of flow can be safely handled by a vegetated or earth spillway. Minimum principal spillway capacities for other ponds shall be as shown in Table 2, Minimum Spillway Capacities.

TABLE 2 - Minimum Spillway Capacities				
Drainage Area	Effective Height of Dam ¹	Storage ¹	Minimum Frequency of Design - 24-Hour Duration Storm ²	
			Principal Spillway Capacity	Total Capacity
<i>Acre (ha)</i>	<i>Feet (m)</i>	<i>Acre-feet (ha-m)</i>	<i>Years</i>	<i>Years</i>
20 or less (50 or less)	20 or less (6 or less)	< 50 (< 40)	none	10
20 or less (50 or less)	> 20 (> 6)	< 50 (< 40)	5	25
> 20 (> 50)		< 50 (< 40)	5	25
All others			10	50

¹ As defined under "Conditions Where Practice Applies."

² Select rain distribution based on climatological region.

The crest elevation shall be no less than 0.5 feet (15cm) below the crest of the auxiliary spillway for dams having a drainage area of 20 acres (50ha) or less, and no less than 1 foot (30cm) for those having a drainage area of more than 20 acres (50ha).

When design discharge of the principal spillway is considered in calculating peak outflow through the auxiliary spillway, the crest elevation of the inlet shall be such that the full flow will be generated in the conduit before there is discharge through the auxiliary spillway. The inlets and outlets shall be designed to function satisfactorily for the full range of flow and hydraulic head anticipated.

The capacity of a pipe conduit shall be adequate to discharge long-duration, continuous, or frequent flows without flow through the auxiliary spillways, or as shown on Table 2, whichever is greater. The diameter of the pipe shall not be less than 4 inches (10cm). If the pipe conduit diameter is 10 inches (25cm) or greater, its design discharge may be considered when calculating the peak outflow rate through the auxiliary spillway. Pipe conduits used solely as a water supply pipe through the embankment for watering of livestock shall have a minimum diameter of 1.25 inches (3cm).

Closed conduit spillways designed for pressure flow must have adequate antivortex devices.

Pipe conduits under or through the embankment shall meet the following requirements. The pipe shall be capable of withstanding external loading without yielding, buckling, or cracking. Flexible pipe strength shall not be less than that necessary to support the design load with a maximum of 5 percent deflection. The inlets and outlets shall be structurally sound and made of materials compatible with those of the pipe. All pipe joints shall be made watertight by the use of couplings, gaskets, caulking, or by welding.

For dams 20 feet (6m) or less in effective height, acceptable pipe materials are cast-iron, ductile iron, steel, corrugated steel or aluminum, asbestos-cement, concrete, plastic, vitrified clay with rubber gaskets, and cast-in-place reinforced concrete. Asbestos-cement, concrete, and vitrified clay pipe shall be laid in a concrete bedding. Plastic pipe that will be exposed to direct sunlight shall be made of ultraviolet-resistant materials and protected by coating or shielding, or provisions for replacement should be made as necessary. Connections of plastic pipe to less flexible pipe or structures must be designed to avoid stress concentrations that could rupture the plastic.

For dams more than 20 feet (6m) in effective height, conduits shall be plastic, reinforced concrete, cast-in-place reinforced concrete, corrugated steel or aluminum, ductile iron, or welded steel pipe. The maximum height of fill over any steel or aluminum pipe shall not exceed 25 feet (7.6m). Pipe shall be watertight. The joints between sections of pipe shall be designed to remain watertight after joint elongation caused by foundation consolidation. Concrete pipe shall have concrete bedding or a concrete cradle, if required. Cantilever outlet sections, if used, shall be designed to withstand the cantilever load. Pipe supports shall be provided when needed. Protective coatings of asbestos-bonded, asphalt, or vinyl on galvanized corrugated metal pipe, or coal tar enamel on welded steel pipe should be provided in areas that have a history of pipe corrosion, where the saturated soil resistivity is less than 4,000 ohms-cm, or where soil pH is lower than 5.

Cathodic protection is to be provided for coated welded steel and coated galvanized corrugated metal pipe where soil and resistivity studies indicate that the pipe needs a protective coating, and where the need and importance of the structure warrant additional protection and longevity. If cathodic protection is not provided for in the original design and installation, electrical continuity in the form of joint-bridging straps should be considered on pipes that have protective coatings. Cathodic protection should be added later if monitoring indicates the need.

NRCS National Practice Standard 430-FF provides criteria for cathodic protection of welded steel pipe.

Specifications in Tables 3 and 4 are to be followed for polyvinyl chloride (PVC), steel, and aluminum pipe.

TABLE 3 - Acceptable PVC Pipe for Use in Earth Dams¹		
Nominal Pipe Size <i>Inch(cm)</i>	Schedule or Standard Dimension Ratio (SDR)	Maximum Depth of Fill Over Pipe <i>Feet(m)</i>
4(10) or less	Schedule 40	15(4.5)
	Schedule 80	20(6)
	SDR 26	10(3)
6-12(18-36)	Schedule 40	10(3)
	Schedule 80	15(4.5)
	SDR 26	10(3)

¹ Polyvinyl chloride pipe, PVC 1120 or PVC 1220, conforming to ATSM-D-1785 or ATSM-D-2241.

TABLE 4 - Minimum Gage for Corrugated Metal Pipe [2-2/3-inch x 1/2-inch (70mm x 13 mm) corrugations]¹						
Fill height in feet (m)	Minimum gauge for steel pipe with diameter of inches(cm) of —					
	21 (55) and less	24 (73)	30 (90)	36 (110)	42 (128)	48 (146)
1–15 (0.3-4.5)	16	16	16	14	12	10
15–20 (4.5-6)	16	16	16	14	12	10
20–25 (6-7.5)	16	16	14	12	10	10
Fill Height in Feet (m)	Minimum thickness in inches(mm) for aluminum pipe ² with diameter of inches(cm) of —					
	21 (55) and less	24 (73)	30 (90)	36 (110)		
1 - 15 (0.3-4.5)	0.06 (1.5)	0.06 (1.5)	0.075 (1.9)	0.075 (1.9)		
15 - 20 (4.5-6)	0.06 (1.5)	0.075 (1.9)	0.105 (2.7)	0.105 (2.7)		
20 - 25 (6-7.5)	0.06 (1.5)	0.105 (2.7)	0.105 (2.7)	----		

¹ Pipe with 6, 8, and 10-inch (15, 20, and 25cm) diameters has 1-1/2 inch x 1/4 inch (38mm x 6mm) corrugations.

² Riveted or helical fabrication.

³ Not permitted.

Seepage control along a pipe conduit spillway shall be provided if any of the following conditions exist:

1. The effective height of dam is greater than 15 feet (4.5m).
2. The conduit is of smooth pipe larger than 8 inches (20cm) in diameter.
3. The conduit is of corrugated pipe larger than 12 inches (30cm) in diameter.

Seepage along pipes extending through the embankment shall be controlled by use of a filter and drainage diaphragm, unless it is determined that anti-seep collars will adequately serve the purpose.

Drainage Diaphragm

The drainage diaphragm shall function as both a filter for adjacent soils and a drain for the seepage water

that it intercepts. The drainage diaphragm is to consist of sand, meeting fine concrete aggregate requirements (ASTM C-33 Fine Aggregate, or Michigan DOT 2NS). If unusual soil conditions exist, a special design analysis shall be made.

The drainage diaphragm shall be a minimum of 2 feet (0.6m) thick and extend vertically upward and horizontally at least three times the pipe diameter, and vertically downward at least 18 inches (45cm) beneath the conduit invert. The drain diaphragm shall be located immediately downstream of the cutoff trench, approximately parallel to the centerline of the embankment.

The drain shall be outletted at the embankment downstream toe, preferably using a drain backfill envelope continuously along the principal spillway conduit to where it exits the embankment. The drainfill shall be outletted through a riprap section. The drainfill shall be protected from piping through the riprap by placement of an 8 ounce per square yard (271 g/m^3) nonwoven geotextile or properly grade gravel between the drainfill and riprap.

Anti-Seep Collars

When anti-seep collars are used in lieu of a drainage diaphragm, they shall have a watertight connection to the pipe. Maximum spacing shall be approximately 14 times the minimum projection of the collar measured perpendicular to the pipe. Collar material shall be compatible with pipe materials. The anti-seep collar(s) shall increase by at least 15 percent the seepage path along the pipe.

Trash Guard

To prevent clogging of the conduit, an appropriate trash guard shall be installed at the inlet or riser.

Auxiliary Spillways

The auxiliary spillway or a combination of auxiliary spillway and principal spillway, as allowed, shall safely pass the total design storm shown in Table 2.

An auxiliary spillway must be provided for each dam, unless the principal spillway is large enough to pass the peak discharge from the routed design hydrograph and the trash that comes to it without overtopping the dam. The following are minimum criteria for acceptable use of a closed conduit principal spillway without an auxiliary spillway: a conduit with a cross-sectional area of 3 square feet (0.25 m^2) or more, an

inlet that will not clog, and an elbow designed to facilitate the passage of trash.

The minimum capacity of a natural or constructed auxiliary spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 2, less any reduction creditable to conduit discharge and detention storage.

The auxiliary spillway shall safely pass the peak flow, or the storm runoff shall be routed through the reservoir. The routing shall start either with the water surface at the elevation of the crest of the principal spillway or at the water surface after 10 days' drawdown of the routed principal spillway design storm, whichever is higher. The 10-day drawdown shall be computed from the crest of the auxiliary spillway or from the elevation that would be attained if the entire principal spillway design storm were impounded, whichever is lower. Auxiliary spillways shall provide for passing the design flow at a safe velocity to a point downstream where the dam will not be endangered.

Constructed auxiliary spillways are open channels that usually consist of an inlet channel, a control section, and an exit channel. They shall be trapezoidal and shall be located in undisturbed or compacted earth. The side slopes shall be stable for the material in which the spillway is to be constructed. The auxiliary spillway shall have a bottom width of not less than 10 feet (3m).

Upstream from the control section, the inlet channel shall be level for the distance needed to protect and maintain the crest elevation of the spillway. The inlet channel may be curved to fit existing topography. The grade of the exit channel of a constructed auxiliary spillway shall fall within the range established by discharge requirements and permissible velocities. The exit channel shall have a straight alignment.

Structural Auxiliary Spillways

If chutes or drops are used for principal spillways or principal auxiliary or auxiliary spillways, they shall be designed according to the principles set forth in the Engineering Field Manual for Conservation Practices and the National Engineering Handbook, Section 5, Hydraulics; Section 11, Drop Spillways; and Section 14, Chute Spillways. The minimum capacity of a structural spillway shall be that required to pass the peak flow expected from the total capacity design storm of the frequency and duration shown in

Table 2, less any reduction creditable to conduit discharge and detention storage.

Design Criteria For Excavated Ponds

Geologic Investigation

A subsurface investigation is required for all excavated ponds. Subsurface investigations shall be conducted by individuals trained in soil science, engineering, geology, or a related field. The number and depth of test holes, pits, or borings will vary depending on the planned pond size and length and the conditions encountered during the investigation such as the complexity of the soils, the depth to groundwater, and the presence or absence of seeps. At a minimum, there shall be one test hole, pit, or boring for each acre (2.5h) of planned pond area, plus at least one test hole, pit, or boring for the auxiliary spillway, if applicable. The log for each test hole, pit, or boring shall indicate the following:

- Existing ground surface elevation.
- A description of the soil material encountered using the Unified Classification System.
- Depth to changes in the soil material encountered.
- Depth to high water (note method of determination: mottling, free water encountered, etc.).
- Depth to bottom of test hole, pit, or boring.

The location and log information for all test holes, pits, and/or borings in or near the structure shall be shown on the construction drawings.

Runoff

Provisions shall be made for a pipe and auxiliary spillway if necessary (see Table 2). Runoff flow patterns shall be considered when locating the pond and placing the spoil.

Side Slopes

Side slopes of excavated ponds shall be stable and shall not be steeper than one horizontal to one vertical. If livestock will water directly from the pond, a watering ramp of ample width shall be provided. The ramp shall extend to the anticipated low water elevation at a slope no steeper than five horizontal to one vertical.

Inlet Protection

If surface water enters the pond in a natural or excavated channel, the side slope of the pond shall be protected against erosion.

Excavated Material

The material excavated from the pond shall be placed so that its weight will not endanger the stability of the pond side slopes and so that it will not be washed back into the pond by rainfall. It shall be disposed of in one of the following ways:

1. Uniformly spread to a height that does not exceed 3 feet (1m), with the top graded to a continuous slope away from the pond.
2. Uniformly placed or shaped reasonably well, with side slopes assuming a natural angle of repose. The excavated material will be placed at a distance equal to the depth of the pond but not less than 12 feet (3.6m) from the edge of the pond.
3. Shaped to a designed form that blends visually with the landscape.
4. Used for low embankment and leveling.
5. Hauled away.

CONSIDERATIONS

Visual Resources

The visual design of ponds shall be carefully considered in areas of high public visibility and those associated with recreation. The shape and form of ponds, excavated material, and plantings are to relate visually to their surroundings and to their function.

The embankment may be shaped to blend with the natural topography. The edge of the pond may be shaped so that it is generally curvilinear rather than rectangular. Islands may be added for visual interest and to attract wildlife.

Variability of water levels caused by seasonal or climatic changes.

Cultural Resources

Consider the existence of cultural resources in the project area and any project impacts on those resources. Consider conservation or stabilization of archeological, historic, and traditional cultural properties when appropriate.

Fish and Wildlife

Consider short-term and construction-related effects of this practice on the quality of downstream watercourses.

Consider the effects of water level control on the temperatures of downstream water to prevent undesired effects on aquatic and wildlife communities.

Consider building slopes to four horizontal to one vertical where frequent mowing is desired.

PLANS AND SPECIFICATIONS

Plans and specifications for installing ponds shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

Support data documentation requirements are as follows:

- Inventory and evaluation records
 - CONS-6 notes or special report
- Survey notes, where applicable
 - Design survey
 - Construction layout survey
 - Construction check survey
- Design records
 - Physical data, functional requirements, and site constraints, where applicable
 - Soils/subsurface investigation report, where applicable
- Design and quantity calculations
- Construction drawings/specifications with:
 - Location map
 - “Designed by” and “Checked by” names or initials
 - Approval signature
 - Job class designation
 - Initials from preconstruction conference
 - As-built notes
- Construction inspection records
 - CONS-6 notes or separate inspection records
 - Construction approval signature
- Record of any variances approved, where applicable
- Record of approvals of in-field changes affecting function and/or job class, where applicable

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be provided to and reviewed with the landowner. The plan shall include the following items and others as appropriate.

Vegetation damaged by machinery, livestock, wildlife, herbicides, or erosion must be repaired promptly. Seeding shall be protected from concentrated flow and grazing until vegetation is established. Minimize damage to vegetation by excluding livestock whenever possible, especially during wet periods.

Inspect embankments regularly, especially following heavy rains. Damaged areas will be filled, compacted, and seeded immediately.

Mow the vegetation between August 1 and August 20 to: avoid peak nesting seasons and reduced winter cover for wildlife; maintain capacity by reducing sediment deposition; and control woody vegetation.

Control noxious weeds.

A plan shall be prepared with the owner/operator for maintaining the embankment, the design capacity, the vegetative cover, and the outlet. After each large storm, structures shall be checked and needed maintenance performed. If the storage provided for sediment has been used, structures must be cleaned out to restore capacity. Excavations for fill material shall be made in a manner that enhances the topography.